CLAIMS

1. A photodiode comprising:

a conductive film having: an aperture having a diameter smaller than wavelength of incident light, and a periodic structure provided around said aperture for producing a resonant state by an excited surface plasmon in a film surface of said conductive film by means of the incident light to said film surface; and

a semiconductor layer provided in a vicinity of said aperture of said conductive film and in contact with said conductive film;

wherein said photodiode detects near-field light that is generated at an interface between said conductive film and said semiconductor layer by said excited surface plasmon.

2. The photodiode according to claim 1, wherein said conductive film is a metal film through which said incident light does not pass at locations other than said aperture.

3. The photodiode according to claim 1 or 2, wherein a region in which a Schottky barrier formed by said conductive film and said semiconductor layer appears substantially matches a region of generation of said near-field light.

4. The photodiode according to claim 1 or 2, wherein said periodic structure is composed of surface irregularities having a period in a direction of increasing distance from said aperture.

5. A photodiode comprising:

a conductive film having a first surface and a second surface and including: an aperture having a diameter smaller than wavelength of incident light that is formed from said first surface side; and a periodic structure composed of surface irregularities having a period in a direction of increasing distance from said aperture;

a first semiconductor layer of one conductive type provided in a vicinity of said aperture of said conductive film and in contact with the second surface of said conductive film; and

a second semiconductor layer of said one conductive type in which concentration of impurities is higher than in said first semiconductor layer, and which contacts a surface of said first semiconductor layer that is opposite to another surface in contact with the second surface of said conductive film.

6. The photodiode according to claim 5, wherein said conductive film is composed of a metal film, and said surface irregularities are formed in said first surface.

7. The photodiode according to claim 5, wherein said periodic structure is composed of concentric grooves that take said aperture as center.

8. The photodiode according to any one of claims 5 to 7, further comprising:

a first electrode electrically connected to said first semiconductor layer and a second electrode electrically connected to said conductive film for applying a reverse bias voltage for forming a Schottky barrier in a vicinity of a

junction with said conductive film of said second semiconductor layer;

wherein a thickness of said second semiconductor layer interposed between said first semiconductor layer and said conductive film is equal to or less than a length of bleeding of near-field light that appears on said first-surface side at a location of said aperture when light is irradiated onto said conductive film from said second surface.

9. The photodiode according to any one of claims 5 to 7, wherein said aperture has a bottom surface portion that is a part of said conductive film.

10. The photodiode according to any one of claims 5 to 7, wherein a scattering member composed of a conductive material for scattering light is arranged in said aperture.

11. The photodiode according to claim 9, comprising a scattering member composed of conductive material for scattering light, said scattering member being embedded in said second semiconductor layer side from an interface between said bottom surface portion and said second semiconductor layer corresponding to the position of said aperture.

12. The photodiode according to any one of claims 5 to 7, wherein said aperture penetrates said conductive film and reaches said second semiconductor layer, and of said conductive film, a periphery around said aperture contacts said second semiconductor layer.

13. The photodiode according to claim 12, wherein a scattering member

composed of a conductive material for scattering light is embedded in a surface of said second semiconductor layer corresponding to the position of said aperture.

14. The photodiode according to any one of claims 5 to 7, wherein a transparent film having an index of refraction substantially equal to that of said second semiconductor layer is provided on said first surface of said conductive film.

15. The photodiode according to claim 14, further comprising an antireflection film for incident light provided on said transparent film.

16. The photodiode according to any one of claims 5 to 7, wherein said conductive film is a metal film and the diameter of said aperture is at least 1/10 but no greater than 1/2 the wavelength of said incident light.

17. The photodiode according to claim 16, wherein the period of said periodic structure is equal to or less than the wavelength of said incident light.

18. The photodiode according to claim 16, wherein the period of said periodic structure is set to a resonant wavelength of the surface plasmon excited on said conductive film by said incident light.

19. The photodiode according to claim 16, wherein said metal film has a thickness no greater than 1000 nm but at least 100 nm at concave portions of said periodic structure, and a depth of said surface irregularities is at least 20

nm but no greater than 200 nm.

20. The photodiode according to claim 8, wherein a thickness of said second semiconductor layer interposed between said first semiconductor layer and said conductive film is at least 50 nm but no greater than 100 nm.

21. A method for fabricating a photodiode which has a conductive film having an aperture and periodic surface irregularities that takes said aperture as center, and a semiconductor layer joined to said conductive film at a position of a bottom of said aperture, the method comprising the steps of:

defining and forming said semiconductor layer such that a region for carrying out photoelectric conversion is limited to a position corresponding to the bottom of said aperture;

forming said conductive film; and

forming said aperture and said surface irregularities in said conductive film such that said aperture and said surface irregularities are matched to said region.

22. An optical module comprising:

a photodiode according to claim 1 or 5 for detecting signal light emitted from an optical fiber to supply it as an electrical signal; and

a preamplifier for amplifying the electrical signal.

23. The optical module according to claim 23, comprising:

a case; and

a means for optically coupling said optical fiber and said photodiode;

wherein said photodiode and said preamplifier are accommodated in said case.

24. An optical interconnection module comprising:

a photodiode according to claim 1 or 5 for receiving incidence of light emitted from a first optical fiber to generate a first signal current;

a light source for generating a signal light that is irradiated into a second optical fiber; and

a mounting board on which said photodiode and said light source are arranged;

wherein said first signal current is supplied to an LSI, and said light source generates the signal light in accordance with the second signal current from said LSI.

25. The optical interconnection module according to claim 24, further comprising:

a first coupling means for optically coupling said first optical fiber and said photodiode; and

a second coupling means for optically coupling said light source and said second optical fiber.